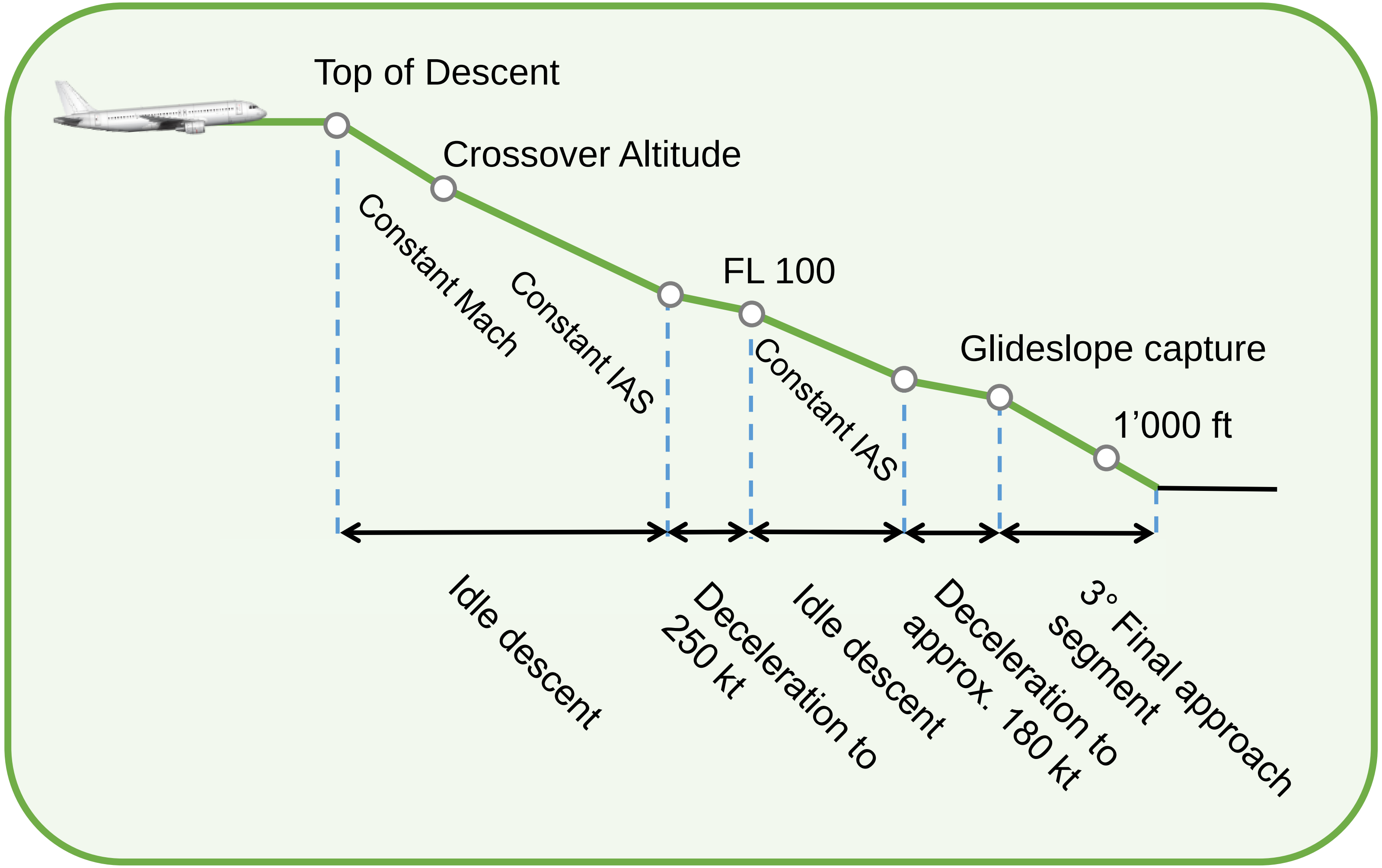
FABEC Vertical Flight Efficiency (VFE) Workshop, 7 December 2021

# From CDA to the Continuous Idle Descent (CID): VFE with dynamic energy calculation


Martin Gerber – Technical Pilot Airbus A320

# Ideal Descent: Continuous Idle Descent (CID) ∈ CDA

## Pilot's main challenges during unrestricted descent




| | Free vertical profile<br>OP DES | Fixed vertical profile<br>V/S -500 |
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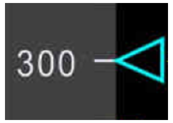
| Fixed speed  | IDLE OK | IDLE NOK |

# Aircraft Energy Management

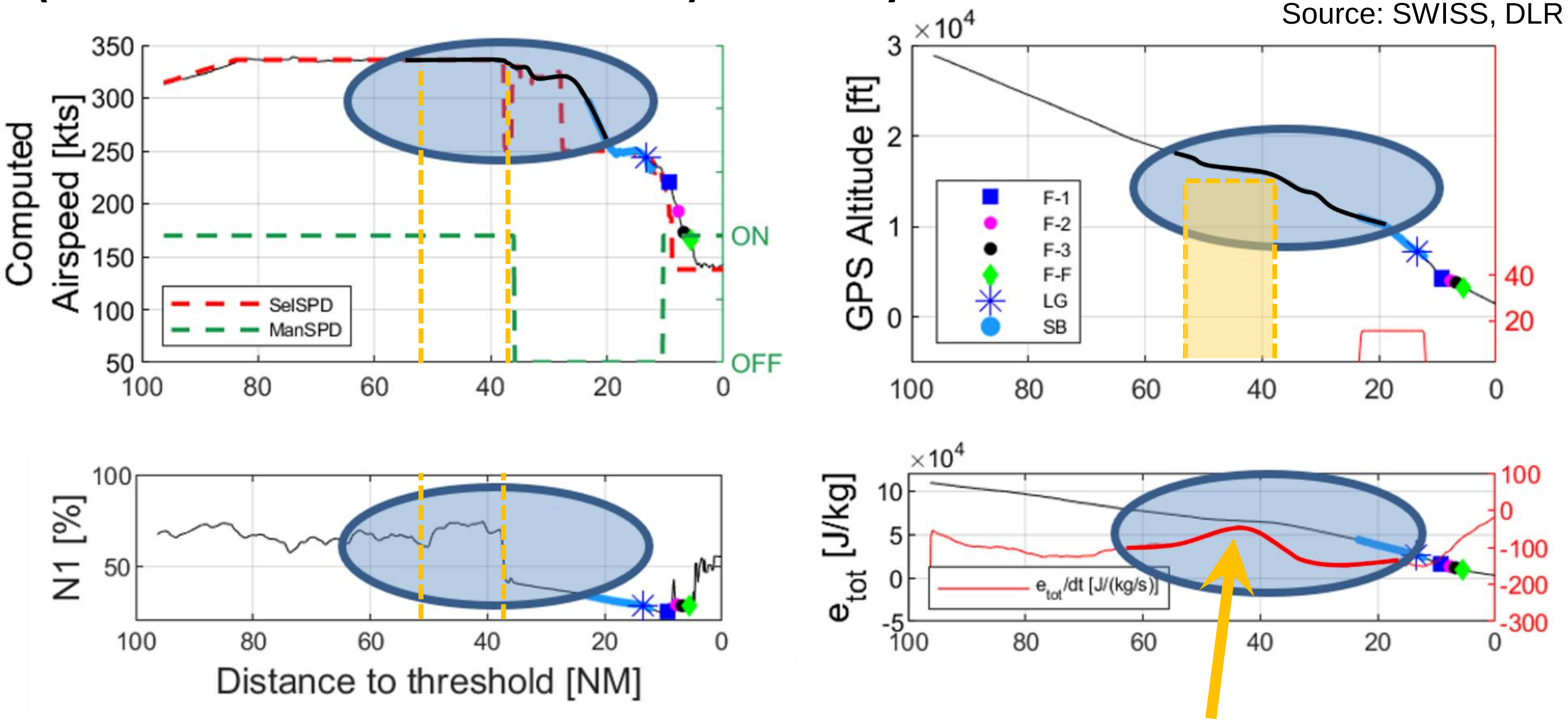
## Kinetic and potential energy

The management of the dissipation of kinetic and potential energy of an aircraft by the flight crew (manual or automation) and by ATC.

Source: SWISS, DLR

**Example #1:**

Maintaining speed at altitude constraint leading to **over-energy** situation




Reduction of energy dissipation rate!

# Aircraft Energy Management

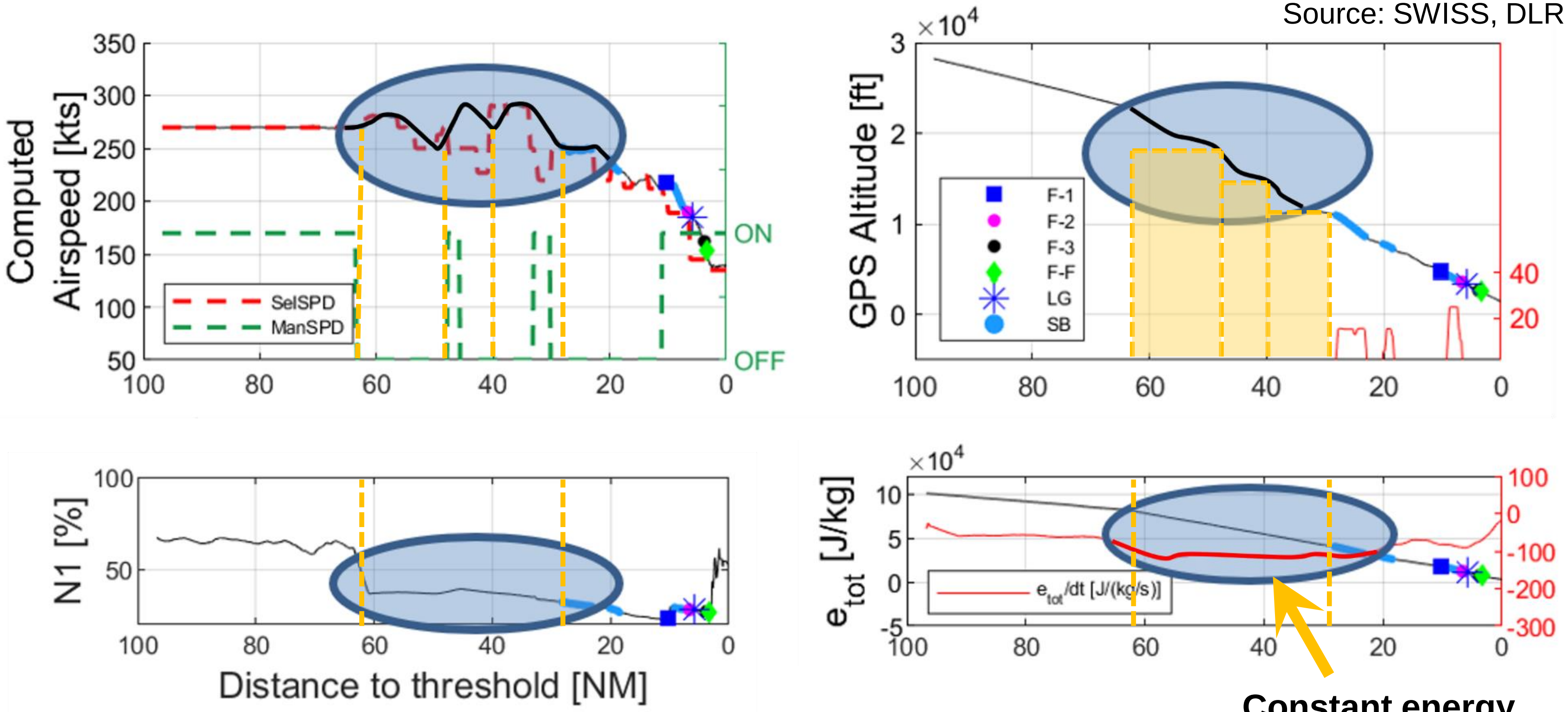
## Kinetic and potential energy

The management of the dissipation of kinetic and potential energy of an aircraft by the flight crew (manual or automation) and by ATC.

Source: SWISS, DLR

**Example #2:**

Speed trading at ALT constraints with constant energy dissipation rate in idle descent




Constant energy dissipation rate!

**Goal: to achieve a CDA in idle thrust (= CID) down to 1’000 ft AGL**

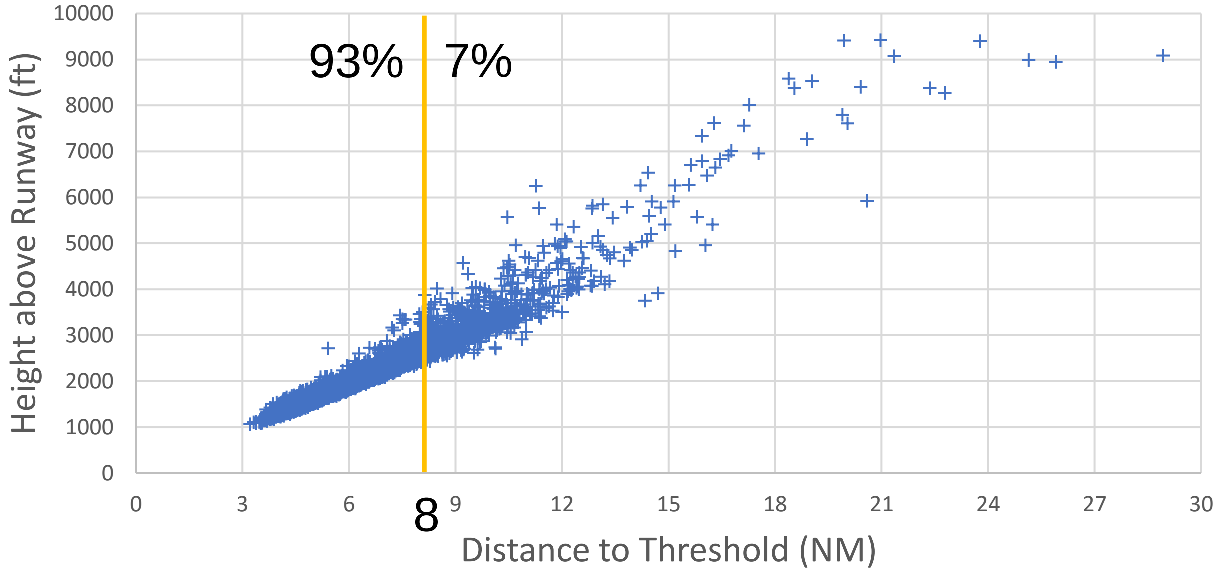
# Consequences of low VFE: suboptimum energy dissipation

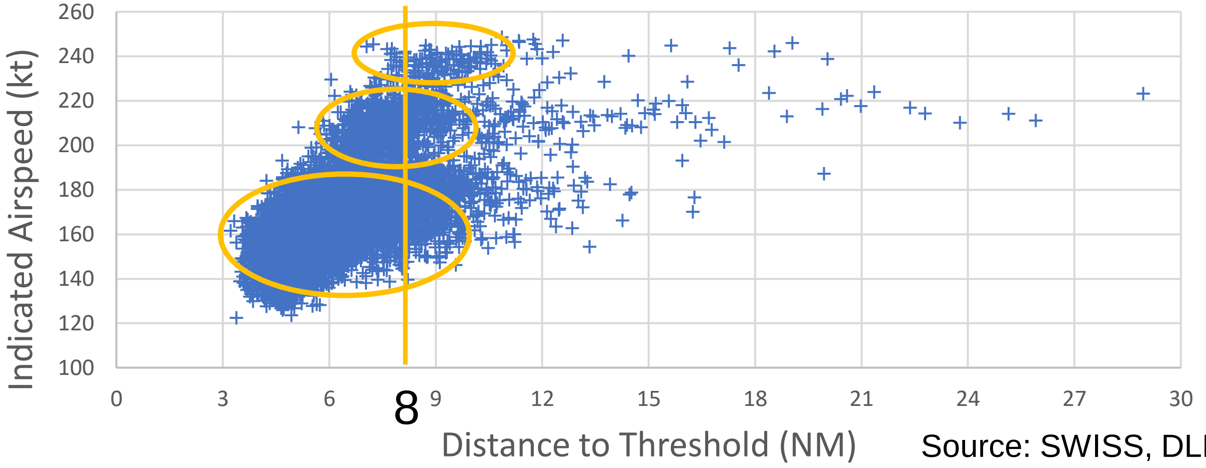
## Analysis of current operation: Zurich

**Example: Zurich RWY 14**

**Landing gear extension**
**→ Significant variation**

- 3 speed-clusters at FAF (240kt, 210kt and 180kt)
- 7% at 8 NM (Final Approach Fix) or more from RWY to dissipate excessive kinetic energy




Source: SWISS, DLR

# The lateral flightpath defines the vertical path

## Without accurate information about the distance to go (DTG) no VFE

Vertical Flight Efficiency is reduced due to:

- ✈ Missing or inaccurate information to pilots about the expected **Distance-to Go** (DTG).
  - *«Expect line-up via WPTxx, WPTxy, FAF»*
  - *«Expect 40NM track miles»*
- ✈ **Not making use of tolerances** in ATC assignments for speed and altitude:
  - *«Descent when ready»*
  - *«Reduce speed to reach 180kt at FAF»*
  - *«Reduce speed 200kt or less»*

# Fixed flight path angle descent profiles

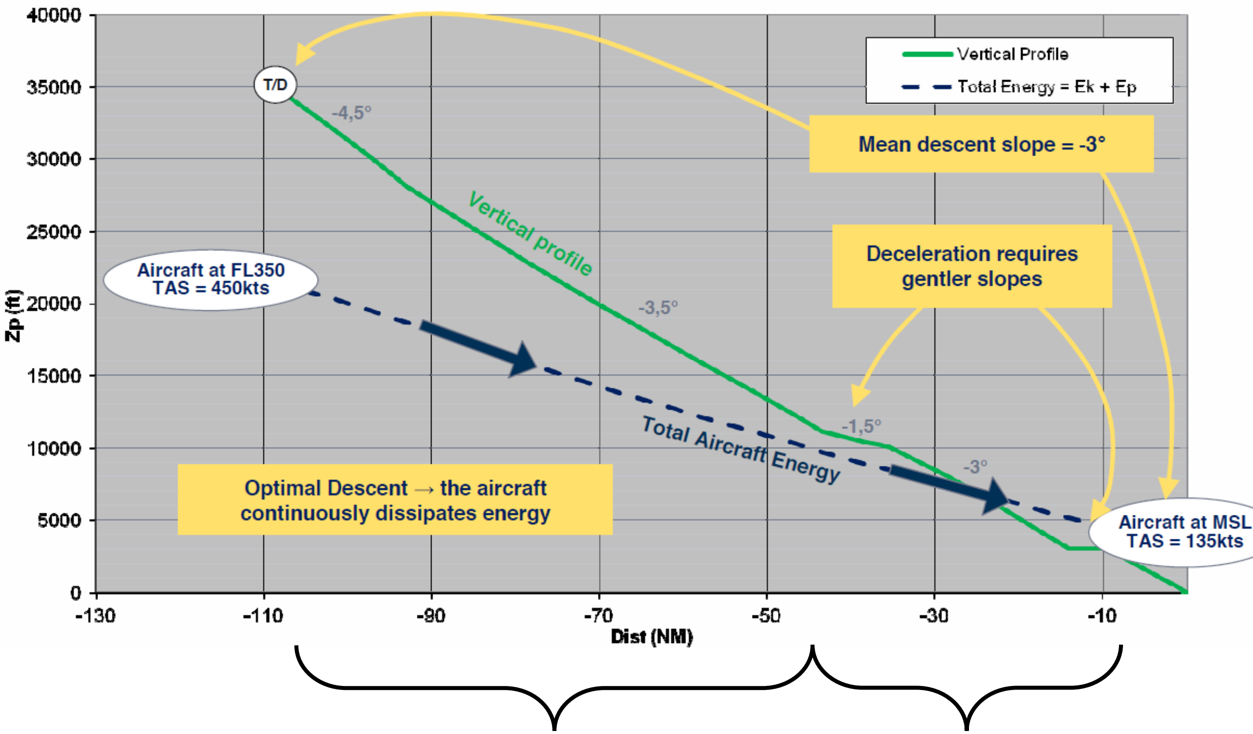
## Aircraft following a vertical profile that tries to match the flight performance data

- Current FMS functions provide a **reference vertical profile** based on static, weight- and wind-dependent performance data.
- ToD depends on selection of FMS FLPLN.
- This reference vertical profile **can only be used with lateral navigation mode.**

→ With radar vectoring: no vertical flight guidance available

→ Only 0.6% use of vertical managed mode below FL100 because of heading clearance [1)]

→ **Vertical profile depends on pilot's best guess!**




Idle Segment Geometrical Segment

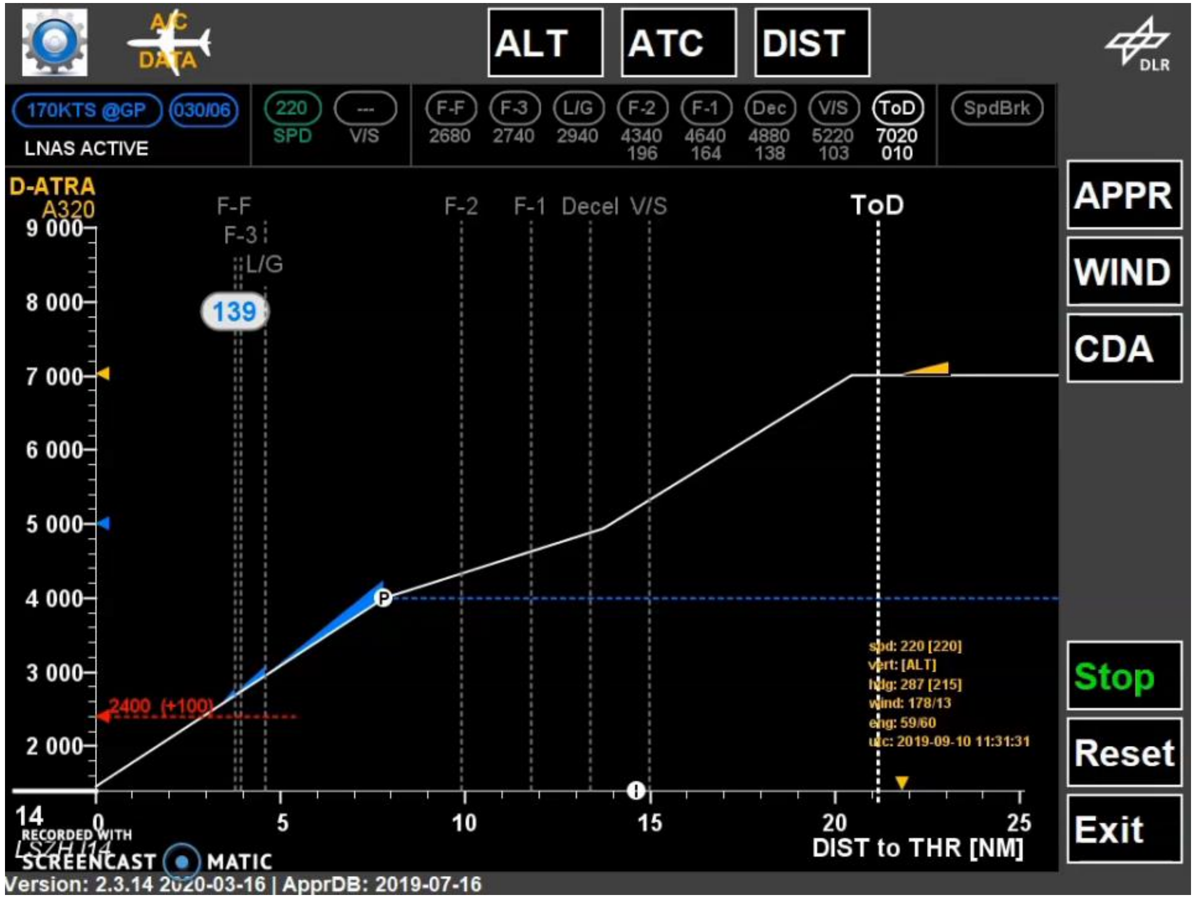
Source: A. Buisson, Airbus. 3rd Eurocontrol CDO Workshop, 2013.

[1)] Source : Thales AVS and NATS data collection of PJ31, PJ31 Appendix N

# Energy-based vertical profile: LNAS

## Real-time forward simulation using a 6 DoF full-flight aircraft model during descent

- Instead of static performance database use a **«mini flight simulator in real-time»** to predict the vertical profile and optimum configuration changes (flaps, landing gear), taking into account ATC constraints.
- LNAS (Low Noise Augmentation System) technology demonstration platform.
- Can be used with DTG information under radar vectoring and not only in NAV mode.




Source DLR, Flight Test Demonstration with A320 ATRA at Zurich Airport, 2019.

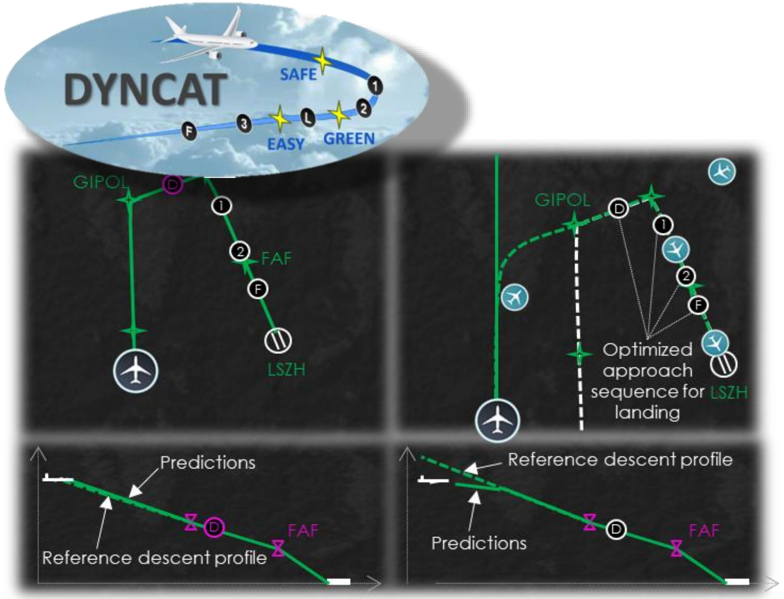
# From EFB-Demonstrator to Avionics-Integration

## Follow-Up Projects with SESAR Joint Undertaking

### VLD 2 ALBATROSS, 2020 - 2023


- Work package: Demonstration of LNAS-CDA from cruise-level top-of-descent in regular revenue operation on Swiss Airlines A320neo. Improvement of LNAS wind data.

### Exploratory Research DYNCAT, 2020 - 2022




Source: Thales Avionics

- Consortium of DLR, Thales Avionics, Empa, Swiss Airlines and Skylab
- Development of an FMS prototype function for dynamic configuration waypoints and energy management
- Distance-to-Go (DTG) / Requested Time of Arrival (RTA) / Permanent Resume Trajectory (PRT) function
- Energy cues for pilot

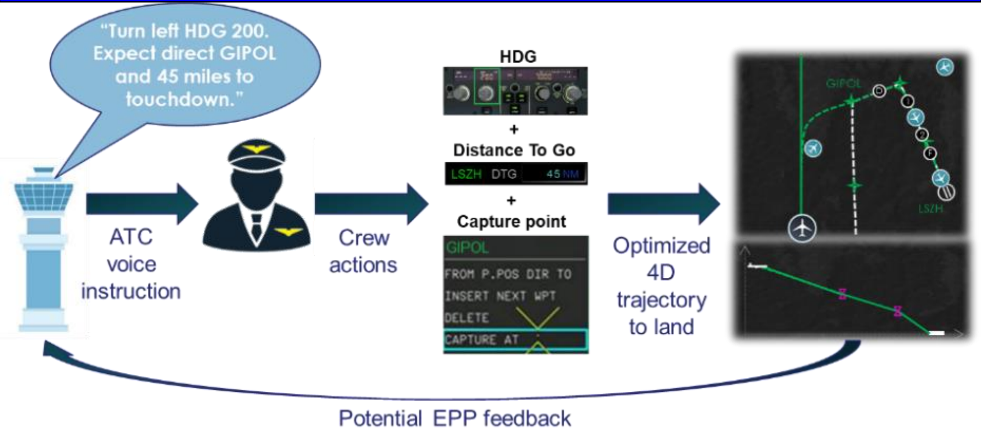
# SESAR ER4 Project DYNCAT

## Dynamic Configuration Adjustment in the TMA

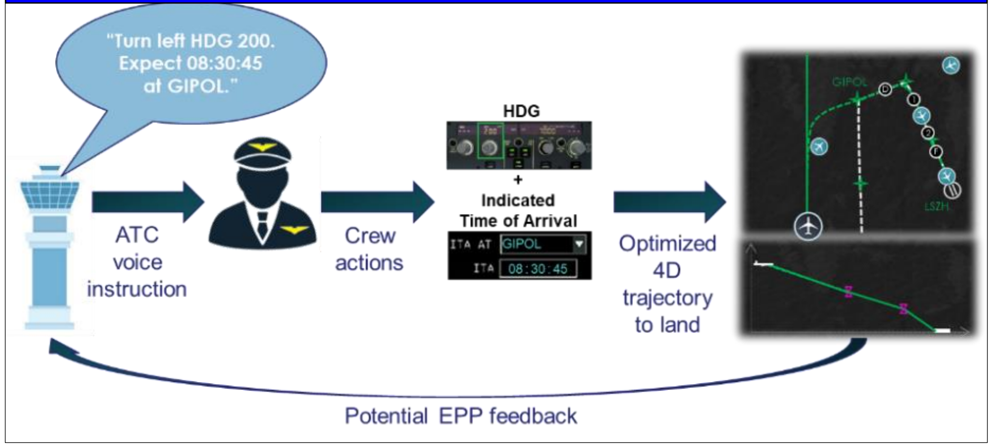
SUPPORTED BY SESAR JOINT UNDERTAKING

DYNCAT

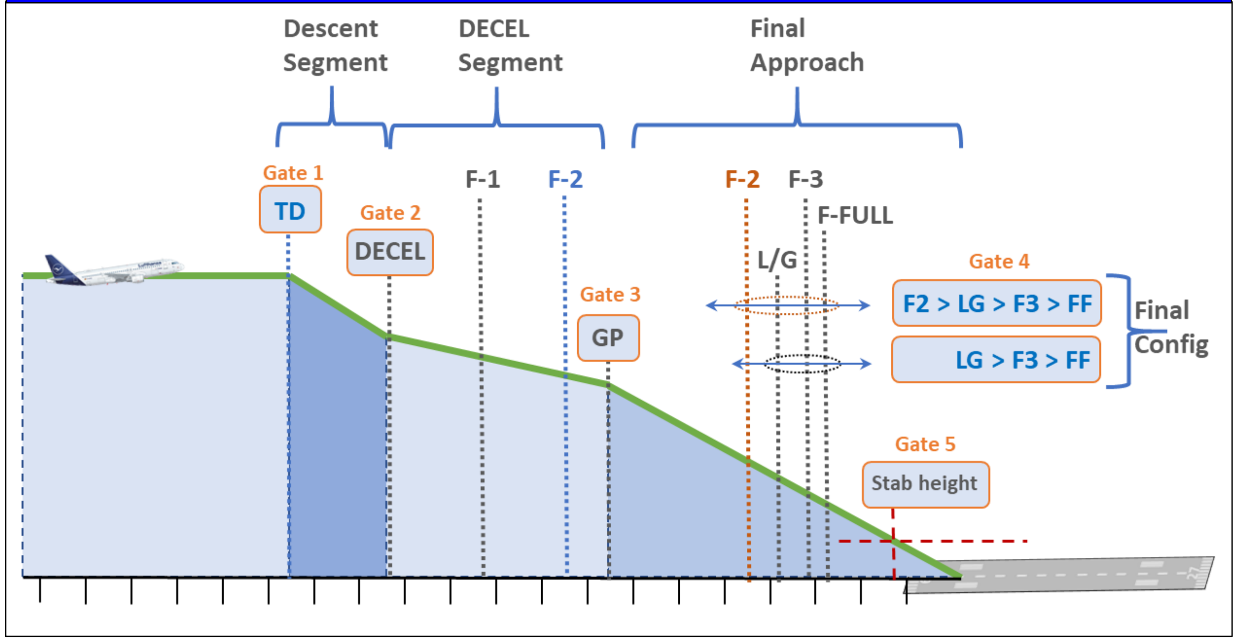
### Vertical Optimization with DTG

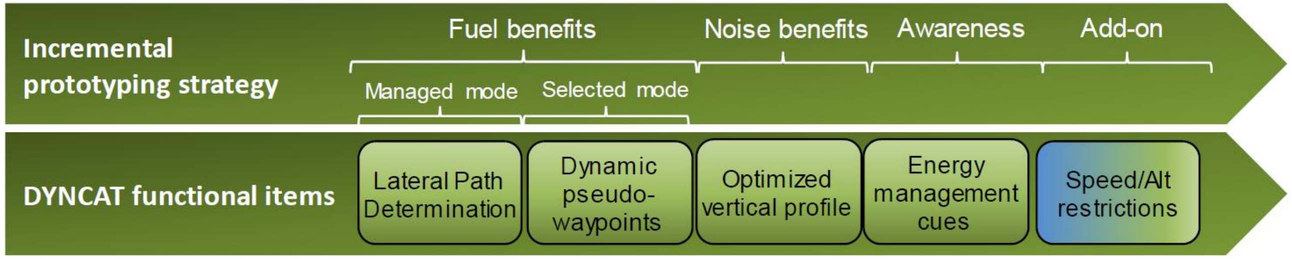



### Vertical Optimization with RTA




### Dynamic Calculation of Vertical Profil and Config Changes

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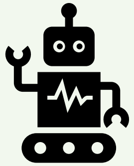
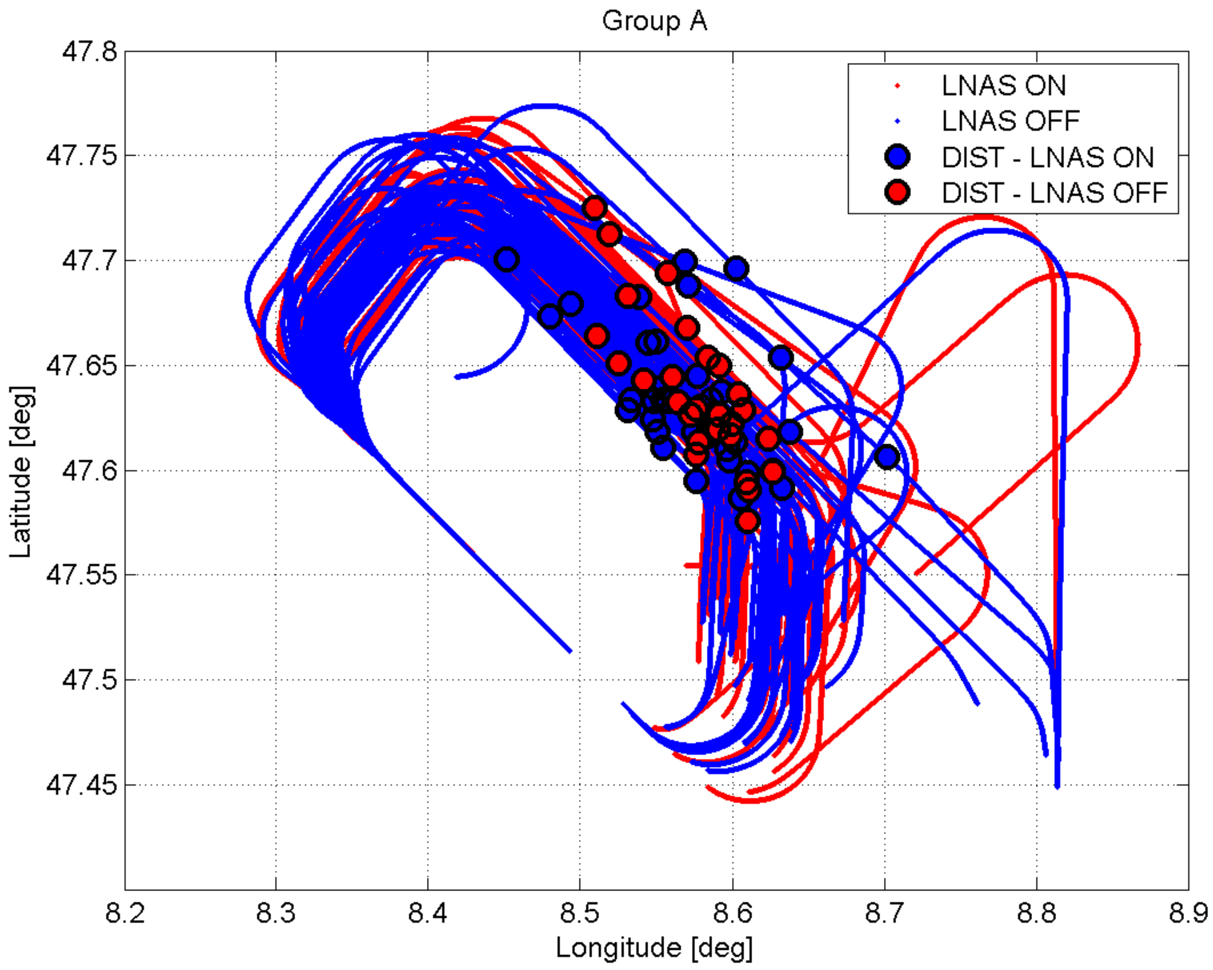
# Results from LNAS Flight Test Campaign, Zurich 2019

## Competition pilot vs. machine to conduct the most energy-optimized descent

- **90 Approaches**
  Zurich Airport RWY 14, 7’000 ft, 220 kt
- **Every approach with radar vectoring and DTG indication**
- **23 Airline Pilots** with and w/o LNAS



vs.

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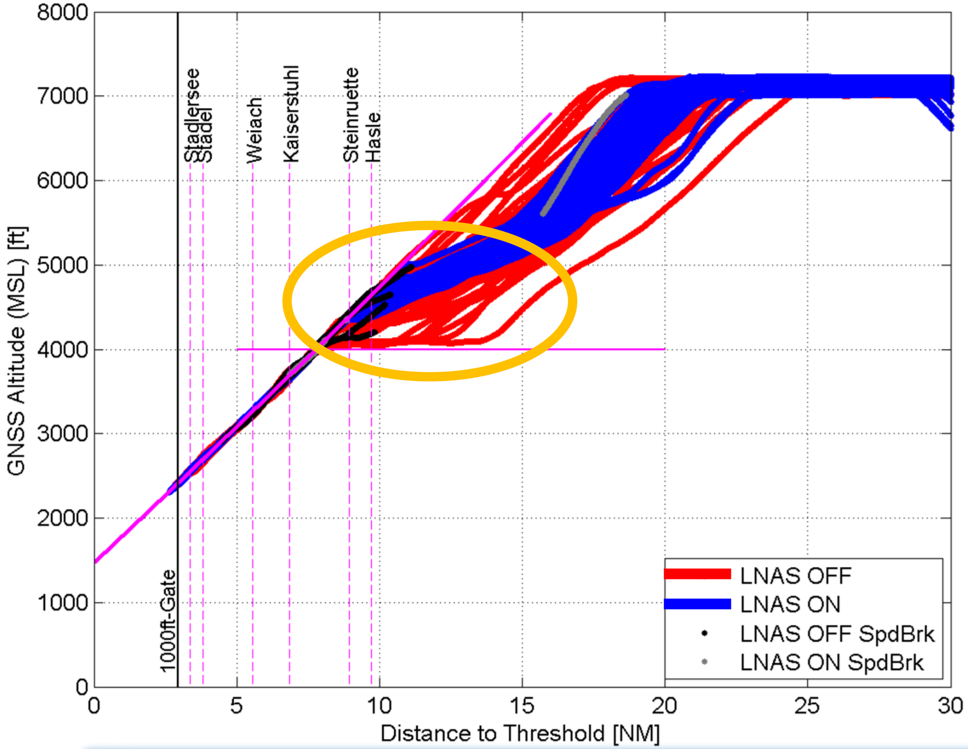
# Results from LNAS Flight Test Campaign, Zurich 2019

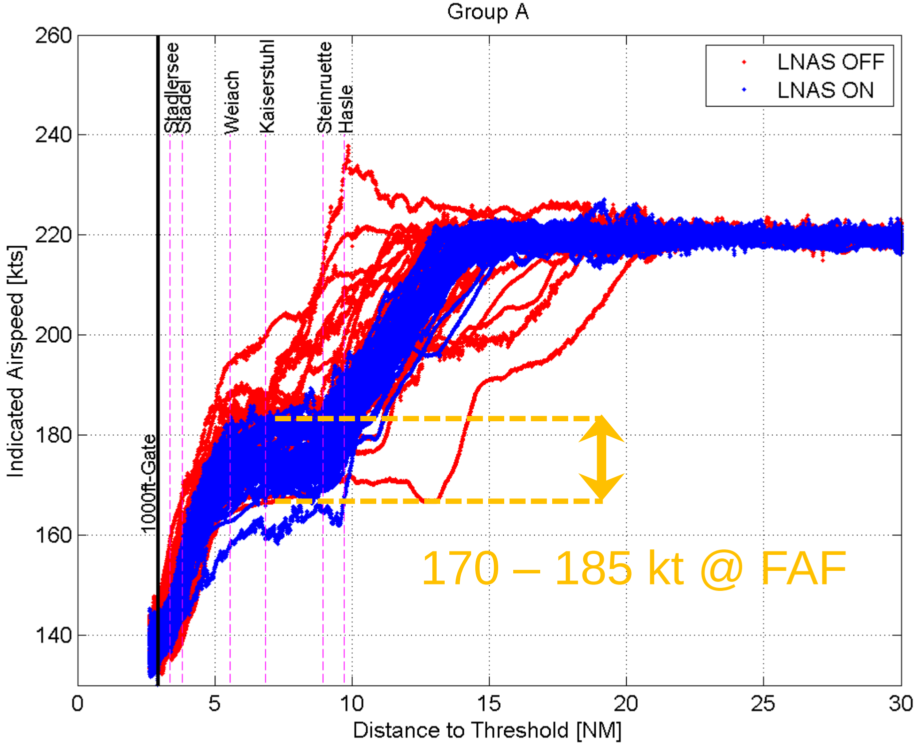
## Competition pilot vs. machine to conduct the most energy-optimized descent

### Vertical Profile




**No inadvertent level segments**

### Speed Profile




**Highly predictable speed profile**

**→ 6% fuel saving on last 26 NM [1)]**

[1)] Corresponds to 500 tons of fuel / year for SWISS A320 flights in 2019

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# How to achieve a better VFE?

## A better mutual understanding of planet «ATCO» and planet «Pilot»

DTG

AMAN

Energy Dissipation

CDO Training 1)

ADS-C EPP

TBO

Assignment of tolerances where possible

Variable Closed-Path Procedures

RTA at FAF

1) See Eurocontrol CCO/CDO training material

# Thank you very much for your attention


## Open for your comments and questions